



Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

August 26, 2002

Fire Fighter Suffers Probable Heart Attack At Fire Station - Kentucky

SUMMARY

On August 12, 2000, a 51-year-old male career Deputy Chief was on duty at his fire station. At 1518 hours, after lying down for approximately 1 hour, the victim arose from his bunk and collapsed. Hearing him fall, crew members came to his assistance and found him unresponsive, with a pulse and shallow respirations. After crew members obtained the medical kit and oxygen equipment, the victim ceased breathing and became pulseless. Approximately 64 minutes later, despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered on the scene and at the hospital, the victim died. Although no autopsy was conducted, the death certificate and the coroner's report listed "acute myocardial infarction" as the immediate cause of death.

The following recommendations address some general health and safety issues. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These selected recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the National Fire Protection Association (NFPA) or fire service labor/management groups.

- *Fire Fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.*
- *Provide fire fighters with medical evaluations and clearance to wear SCBA.*
- *Incorporate exercise stress tests into the Fire Department's medical evaluation program.*
- *Provide exercise equipment in all fire stations.*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Perform an autopsy on all fire fighters who were fatally injured while on duty.*
- *Provide automated external defibrillators on all fire apparatus.*
- *Provide mandatory annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/firehome.html or call toll free 1-800-35-NIOSH



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Although unrelated to this fatality, the Fire Department should consider this additional recommendation based on safety considerations:

- *Provide adequate fire fighter staffing to ensure safe operating conditions.*

INTRODUCTION AND METHODS

On August 12, 2000, a 51-year-old male Deputy Chief lost consciousness while on duty at his fire station. Despite CPR and ALS administered by crew members, the ambulance crew, and in the emergency department, the victim died. On October 11, 2001, NIOSH contacted the affected Fire Department to initiate the investigation. On October 29, 2001, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation Team traveled to Kentucky to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel interviewed the

- Fire Chief
- Deputy Fire Chief/Safety Officer
- Crew members on duty with the victim
- Victim's wife

During the site visit NIOSH personnel reviewed

- Fire Department policies and operating guidelines
- Fire Department training records
- Fire Department annual report for 2000
- Fire Department incident report
- Emergency medical service (ambulance) incident report
- Hospital emergency department report
- Fire Department physical examination protocols
- Death certificate
- Coroner's report
- Past medical records of the deceased

INVESTIGATIVE RESULTS

Incident. On August 12, 2000, the victim arrived for work at Station 1 of the involved Fire Department at approximately 0730 hours. After remaining crew members arrived for work by 0800 hours, they ate breakfast. After breakfast, crew members performed equipment checks and station maintenance while the victim input hydrant test information into the computer. According to crew members, during the morning hours the victim complained of being cold and looked pale. At approximately 1200 hours, the crew ate lunch. After lunch, at approximately 1230 hours, the victim stated that he was going to the bunkroom to lie down (not normal behavior according to crew members). While the victim was in the bunkroom he telephoned a friend at approximately 1500 hours and talked for approximately 15 minutes. At 1518 hours, the victim emerged from the bunkroom and, as he entered the hallway, collapsed into the door frame and then onto the floor. Crew members, hearing him fall, ran to his aid. They found him face down with injuries to his nose and face from the fall. Initial assessment by crew members found the Deputy Chief to be unresponsive, breathing but gurgling, and with a pulse. While another crew member notified 911 of a man down, a third crew member ran downstairs to the engine bay to retrieve a medical kit and oxygen equipment. After the medical kit and oxygen equipment arrived, the victim began snoring respirations and became pulseless. CPR (chest compressions and assisted ventilations via bag-valve-mask) began.

At 1519 hours, 911 notified the ambulance service of a "code blue." Ambulance 59 (one Paramedic, one Emergency Medical Technician [EMT], and a paramedic student) responded immediately and arrived on the scene at 1522 hours. After assessing the victim, he was found to be unresponsive, not breathing, and pulseless with CPR in progress. A cardiac monitor was attached to the victim, revealing



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ventricular fibrillation (V.Fib) (a heart rhythm unable to sustain life), which was immediately defibrillated (shocked). After two additional shocks were delivered, the victim's heart rhythm reverted to asystole (no heartbeat). ACLS measures, including intubation and intravenous therapy, were begun. The cardiac monitor again revealed V.Fib., and three additional shocks (total of six) were administered without change in patient status. The victim was then loaded onto a stretcher, carried downstairs, and placed into the ambulance, which began transport to a nearby hospital at 1545 hours and arrived at the hospital emergency department (ED) at 1552 hours. Inside the ED, a cardiac monitor revealed pulseless electrical activity (PEA). CPR and ACLS measures continued until 1622 hours, when the victim was pronounced dead by the attending physician.

Medical Findings. The death certificate was completed by the County Coroner, who listed "Acute myocardial infarction" as the immediate cause of death. The coroner's report, also completed by the County Coroner, also listed "acute myocardial infarction" as the cause of death. No autopsy was performed.

A carboxyhemoglobin level to evaluate the victim's exposure to carbon monoxide was not checked since the onset of symptoms was at the fire station.

The Deputy Chief had the following risk factors for coronary artery disease (CAD): advancing age (greater than 45 years old), male gender, smoking, and obesity. The victim was not currently prescribed any medications. In April 2000, the victim had an annual physical examination that is given to all career fire fighters. The exam revealed a height of 5 feet, 7 inches, a weight of 237 pounds, and a blood pressure of 160/80. He was cleared for "full duty." In July 2000, the victim sought medical treatment of epigastric and substernal chest pain. His private physician ordered an electrocardiogram (ECG)

which revealed poor R-wave progression but was otherwise normal. Based on the pain characteristics, his physician considered the symptoms to be of gastrointestinal (GI) origin. He ordered an upper GI X-ray which revealed a sliding hiatal hernia, and antacid medications were prescribed. No further workup was ordered. The private physician did not inform the City physician of the results of this medical evaluation.

According to his wife and coworkers, the Deputy Chief did not express symptoms of chest pain or any other symptom indicative of a heart attack at any time preceding the incident.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the NIOSH investigation, the combination Fire Department consisted of 17 career fire fighters and 24 paid/call volunteers and served a daytime population of 45,000 and a nighttime population of 4,500 in a geographic area of 7 square miles. There are two fire stations. Fire fighters work the following schedule: 24 hours on duty, 48 hours off duty, from 0800 hours to 0800 hours.

In 2000, the Department responded to 358 calls: 129 false alarms, 104 rescue/medical calls, 35 structure fires, 19 vehicle fires, 19 good-intent calls, 16 hazardous-condition calls, 9 other fires, 9 service calls, 8 wildland fires, 8 rubbish fires, and 2 overpressure calls.

Training. The Fire Department requires all new career fire fighter applicants to pass a written exam, a physical ability test, and an oral interview before being hired. Once hired, the recruit must pass a preemployment physical examination and a urine drug screen. Newly hired fire fighters receive 412 training hours within the first year and become certified as a Fire Fighter I and II. Once state-



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certified, fire fighters receive recurrent training in their station on each shift.

Paid/call volunteer fire fighter applicants must pass an oral interview and have some fire fighter training prior to being selected as a member. Once selected as a member, the volunteer fire fighter receives 150 hours training to become certified as Fire Fighter I and II. Recurrent training occurs weekly. The State requirement for annual fire fighter recertification is 100 hours for career fire fighters and 20 hours for volunteers. Annual recertification is required for hazardous- materials certification. Biannual recertification is required for EMTs and paramedics. The victim was trained as a Fire Fighter II, Driver/Operator, First Responder, Fire Officer, Fire Investigator, Hazardous Materials operations level, and he had 19 years of fire fighting experience.

Preemployment/Preplacement Evaluations. The Fire Department requires a preemployment/preplacement medical evaluation for career new hires, regardless of age. The components of this evaluation are listed below:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Urine drug screen

New paid/call volunteers are not offered a preemployment evaluation.

These evaluations are performed by a local physician under contract with the City. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made by the examining physician and forwarded to the City Safety Officer.

A timed performance evaluation of typical fire fighting duties (physical ability test) is also required of all career fire fighter applicants before being hired.

Applicants have their vital signs checked by FD Paramedics before performing the physical ability test, but prior medical clearance is not given by a physician.

Periodic Evaluations. Annual medical evaluations are required for all career fire fighters. Paid/call volunteer fire fighters are not offered the evaluation. Components are the same as the preemployment medical evaluation with one exception: the urine drug test is not conducted. These evaluations are performed by the same physician performing the preemployment medical evaluations.

Medical clearance for SCBA use will be conducted by this FD annually, beginning in 2002. If an employee is injured at work, he/she must be cleared for “return to work” by a physician approved by the State Worker’s Compensation Board. In addition, if a fire fighter has a nonoccupational injury or medical condition resulting in one or more missed shifts, the Chief of the FD can require that individual be cleared for “return-to-work” by their personal physician.

All fire fighters have access to a City-owned exercise facility that contains strength and aerobic equipment as well as tennis and basketball courts. Wellness programs, including annual health maintenance checks, are conducted by the City.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.¹ Risk factors for its development include age over 45, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes.^{2,3} The victim had four of these risk factors (age over 45, male gender, smoking, and obesity).



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The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.⁴ However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.⁵ Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.⁶ This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Since an autopsy was not performed, it cannot be determined if a thrombus was present.

Blood clots, or thrombus formation, in coronary arteries are initiated by disruption of atherosclerotic plaques. Certain characteristics of the plaques (size, composition of the cap and core, presence of a local inflammatory process) predispose the plaque to disruption.⁶ Disruption then occurs from biomechanical and hemodynamic forces, such as increased blood pressure, increased heart rate, increased catecholamines, and shear forces, which occur during heavy exercise.^{7,8}

Fire fighting is widely acknowledged to be one of the most physically demanding and hazardous of all civilian occupations.⁹ Fire fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.¹⁰⁻¹² Even when energy costs are moderate (as measured by oxygen consumption) and work is performed in a thermoneutral environment, heart rates may be high (over 170 beats per minute) owing to the insulative properties of the personal protective clothing.¹³ Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.¹⁴⁻¹⁸

By all accounts, before the day of the incident, the victim did not report symptoms of angina and was performing aerobic exercise while on duty.

During the 8 hours on duty, the victim had not performed strenuous activity. It is unclear what triggered this fire fighter's "probable" heart attack, subsequent cardiac arrest, and sudden death. The term "probable" is used because autopsy findings (thrombus formation), blood tests (cardiac isoenzymes), or an ECG findings are required to "confirm" a heart attack (myocardial infarction). No autopsy was performed; the victim died before the cardiac isoenzymes became positive, and he had no heartbeat to show the characteristic findings of a heart attack on his ECG. An ECG performed in July 2000 for chest pain/epigastric pain revealed poor progression of R wave but otherwise was within normal limits. The private physician performing the evaluation did not advise the City physician of the results of the evaluation.

To reduce the risk of heart attacks and sudden cardiac arrest among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*.¹⁹ NFPA 1582 recommends a yearly physical evaluation to include a medical history, height, weight, blood pressure, and visual acuity test.¹⁹ NFPA 1582 recommends a thorough examination to include vision testing, audiometry, pulmonary function testing, a complete blood count, urinalysis, and biochemical (blood) test battery be conducted on a periodic basis according to the age of the fire fighter (less than 30: every 3 years; 30-39: every 2 years; over 40 years: every year). The FD offers preemployment/preplacement and periodic physical evaluations to career fire fighters only. The content of the evaluations is not NFPA compliant.



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NFPA 1582 also recommends fire fighters over the age of 35 with risk factors for CAD be screened for obstructive CAD by an EST.¹⁹ Unfortunately, the EST has problems with both false negatives (inadequate sensitivity) and false positives (inadequate specificity), particularly for asymptomatic individuals (individuals without symptoms suggestive of angina), young men, and women.^{20,21} This has led other expert groups to **not** recommend EST for asymptomatic individuals without risk factors for CAD.^{22,23}

When these asymptomatic individuals **have** risk factors for CAD, however, recommendations vary by organization. The American College of Cardiology/American Heart Association (ACC/AHA) identifies two groups for EST: (1) men over the age of 40 with a history of cardiac disease (as a screening test prior to beginning a strenuous exercise program), and (2) men over age 40 with one or more risk factors.²² They define five risk factors for CAD: hypercholesterolemia (total cholesterol greater than 240 mg/dL), hypertension (systolic greater than 40 mm Hg or diastolic greater than 90 mm Hg), smoking, diabetes, and family history of premature CAD (cardiac event in first-degree relative less than 60 years old).²² The U.S. Preventive Services Task Force (USPSTF) does not recommend EST for asymptomatic individuals, even those with risk factors for CAD; rather, they recommend the diagnosis and treatment of modifiable risk factors (hypertension, high cholesterol, smoking, and diabetes).²³

These recommendations change for individuals who might endanger public safety if an acute episode were experienced or those who require high cardiovascular performance such as police and fire fighters. The NFPA recommends fire fighters without CAD risk factors get their first EST at age 40; for those with one or more CAD risk factors, at age 35.¹⁹ NFPA considers CAD risk factors to be family history of premature (less than age 55) cardiac event, hypertension, diabetes mellitus, cigarette smoking,

and hypercholesterolemia (total cholesterol greater than 240 or HDL cholesterol less than 35).¹⁹ The EST should then be performed on a periodic basis, at least once every 2 years.¹⁹ The ACC/AHA indicates that the data are insufficient to justify periodic EST in people involved in public safety; however, as mentioned previously, they recommend that men over age 40 with a history of cardiac disease be screened before beginning a strenuous exercise program.²² Fire suppression activities involve strenuous physical activity; therefore, the ACC/AHA seem to be making a distinction between those already engaged in strenuous physical activity (conditioning), and those **beginning** a strenuous exercise program. The USPSTF indicates that the evidence is insufficient to recommend screening middle age and older men or women in the general population; however, “screening individuals in certain occupations (pilots, truck drivers, etc.) can be recommended on other grounds, including the possible benefits to public safety.”²³

Since the victim had risk factors for CAD, the performance of an EST is recommended by NFPA 1582. However, the AHA and the USPSTF are less clear about whether an EST should have been performed in this individual. Nonetheless, an EST performed in accordance with NFPA 1582 could have identified his possible CAD, thereby leading to further evaluation and treatment, and possibly the prevention of his sudden cardiac death.

As mentioned earlier, this FD requires a candidate performance evaluation consisting of a timed course of typical fire fighting duties. This evaluation is similar to the Candidate Physical Ability Test (CPAT) developed by the Fire Service Joint Labor Management Wellness/Fitness Task Force.²⁴ NFPA 1500 recommends that Fire Departments develop incumbent performance evaluations that reflect the tasks that fire fighters are required to perform such as stair climb, hose drag, equipment carry, ladder



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raise, forcible entry, and search and rescue.²⁵ The Fire Service Joint Labor Management Wellness/Fitness Task Force is in the process of developing practical, valid, and legally defensible incumbent performance evaluations.

RECOMMENDATIONS AND DISCUSSION

The following recommendations address health and safety generally. It is unclear if any of these recommendations could have prevented the sudden cardiac arrest and subsequent death of this fire fighter. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH, but they represent published research or consensus votes of technical committees of the NFPA or fire service labor/management groups.

Recommendation #1: Provide mandatory annual medical evaluations to ALL fire fighters to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of periodic medical evaluations and examinations for fire fighters can be found in NFPA 1582, *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*,¹⁹ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.²⁴ The Department is not legally required to follow any of these standards. Nonetheless, we recommend the City establish the content and frequency to be consistent with the above guidelines.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. NFPA 1582 should be applied in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.²⁵

The success of medical programs hinges on protecting the affected fire fighter. The Department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) if the fire fighter is not medically qualified to return to active fire fighting duties, provide permanent alternate duty positions or other supportive and/or compensated alternatives.

Recommendation #2: Fire Fighters should be cleared for duty by a physician knowledgeable about the physical demands of fire fighting and the various components of NFPA 1582.

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the consensus guidelines published by NFPA 1582, *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians*. To ensure physicians are aware of these guidelines, we recommend that the Fire Department provide the



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contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department not automatically accept the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition but also the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties or guidance documents, such as NFPA 1582. Lastly, we recommend that all return-to-work clearances be reviewed by the City/Fire Department contracted physician. Thus, the final decision regarding medical clearance for return to work lies with the City/Fire Department with input from many sources including the employee's private physician.

Recommendation #3: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees using respiratory protection.²⁶ These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Kentucky is a State-plan state; therefore, public sector employers are required to comply with OSHA standards. However, we recommend following this standard, and a copy of the OSHA medical checklist has been provided to the Fire Department. Given the current periodic medical evaluation required by the Fire Department, this clearance should not involve any additional expense for the Fire Department.

Recommendation #4: Incorporate exercise stress tests into the Fire Department's medical evaluation program.

NFPA 1582 and the IAFF/IAFC wellness/fitness initiative both recommend at least biannual EST for

fire fighters.^{19,24} They recommend that these tests begin at age 35 for those with CAD risk factors, and at age 40 for those without CAD risk factors. The EST could be conducted by the fire fighter's personal physician or the City's contract physician. If the fire fighter's personal physician conducts the test, the results must be communicated to the City physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #5: Provide exercise equipment in all fire stations.

Currently, no fire stations have strength and aerobic exercise equipment. Fire fighters, however, have access to the City Health and Fitness Center. NFPA 1583 recommends providing exercise equipment through the contracted use of a public gym or other facility or placing the equipment directly in the fire stations.²⁷ Contracting the use of a facility requires a company (engine, ladder, etc.) of fire fighters to exercise at the same time daily at a location separate from their fire station. The gym should be centrally located, but due to emergency responses and daily work duties, the facility may not be convenient and thus may be underutilized. The fire companies may also have to be taken out of service during the time of exercise, depending on the location of the facility. Even though fire fighters may utilize the Fitness Center on duty, fire companies are not taken out of service (due to staffing levels) to ensure participation in a fitness program. Locating equipment in the fire stations allows the fire fighters to exercise within the constraints of their daily work schedules and emergency responses while remaining more readily available for response.

Recommendation #6: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.



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Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.²⁸ NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program* requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.²⁵ In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.²⁴ The Fire Department should review these materials to identify applicable elements for the Department. Other large-city negotiated programs can also be reviewed as potential models.

Recommendation #7: Perform an autopsy on all fire fighters who were fatally injured while on duty.

In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.²⁹ This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the Federal government’s Public Safety

Officer Benefits Program, as well as state and local programs; and

- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

Recommendation #8: Provide automated external defibrillators (AEDs) on fire apparatus.

Preservation of human life is the primary responsibility of the fire department during fires and other emergencies. Fire departments should be prepared to perform rescue work and provide emergency care for those injured.³⁰ Such injuries include cardiac arrest. Most of the sudden cardiac deaths in the United States result from ventricular fibrillation. The chain of survival from cardiac arrest includes (1) early access to the emergency medical system (EMS and 9-1-1 system), (2) early CPR, (3) early defibrillation when indicated, and (4) early advanced emergency treatment.³¹ AEDs have caused the cardiac arrest survivability rate to increase from 7 percent (CPR performed only) to 26 percent. When defibrillation is provided within 5-7 minutes, the survival rate is as high as 49 percent.³² To provide emergency medical care, adequate supplies and equipment should be available to treat bleeding, fractures, cardiac arrest, etc. Placing AEDs on fire apparatus, in addition to those defibrillators carried on ambulances, would allow the Fire Department to provide a greater level of emergency medical care to the public.

Recommendation #9: Provide adequate fire fighter staffing to ensure safe operating conditions.

This finding did not contribute to this fatality but was identified during the NIOSH investigation. NFPA 1500 recommends that “members operating in hazardous areas at emergency incidents shall operate



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in teams of two or more.”²⁵ Understaffing causes those members on the scene to work harder and for longer periods of time. Additionally, it requires the use of extra fire companies to meet the demand for manpower. Engine and Ladder Companies should be staffed with four personnel at a minimum.

REFERENCES

1. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine, 14th ed. New York: McGraw-Hill: pp. 222-225.
2. American Heart Association (AHA) [1998]. AHA scientific position, risk factors for coronary artery disease. Dallas, TX.
3. Jackson E, Skerrett PJ, Ridker PM [2001]. Epidemiology of arterial thrombosis. In: Coleman RW, Hirsh J, Marder VIJ, et al., eds. Homeostasis and thrombosis: basic principles and clinical practice. 4th ed. Philadelphia, PA: Lippincott Williams and Wilkins.
4. Fauci AS, Braunwald E, Isselbacher KJ, et al. [1998]. Harrison's principles of internal medicine, 14th ed. New York: McGraw-Hill, p.1348.
5. Shah PK [1997]. Plaque disruption and coronary thrombosis: new insight into pathogenesis and prevention. Clin Cardiol 20 (11 Suppl2): II-38-44.
6. Fuster V, Badimon JJ, Badimon JH [1992]. The pathogenesis of coronary artery disease and the acute coronary syndromes. N Eng J Med 326:242-250.
7. Kondo NI, Muller JE [1995]. Triggering of acute myocardial infarction. J Cardiovasc Risk 2(6):499-504.
8. Opie LH [1995]. New concepts regarding events that lead to myocardial infarction. Cardiovasc Drug Ther 9 Suppl 3:479-487.
9. Gledhill N, Jamnik, VK [1992]. Characterization of the physical demands of firefighting. Can J Spt Sci 17(3):207-213.
10. Barnard RJ, Duncan HW [1975]. Heart rate and ECG responses of fire fighters. J Occup Med 17:247-250.
11. Manning JE, Griggs TR [1983]. Heart rate in fire fighters using light and heavy breathing equipment: simulated near maximal exertion in response to multiple work load conditions. J Occup Med 25:215-218.
12. Lemon PW, Hermiston RT [1977]. The human energy cost of fire fighting. J Occup Med 19:558-562.
13. Smith DL, Petruzzello SJ, Kramer JM, et al. [1995]. Selected physiological and psychobiological responses to physical activity in different configurations of firefighting gear. Ergonomics 38(10):2065-2077.
14. Smith DL, Manning TS, and Petruzzello SJ [2001]. Effect of strenuous live-fire drills on cardiovascular and psychological responses of recruit firefighters. Ergonomics 44(3):244-254.
15. Willich SN, Lewis M, Lowel H, et al. [1993]. Physical exertion as a trigger of acute myocardial infarction. N Eng J Med 329:1684-1690.
16. Mittleman MA, Maclure M, Tofler GH, et al. [1993]. Triggering of acute myocardial infarction by heavy physical exertion. N Eng J Med 329:1677-1683.
17. Siscovick DS, Weiss NS, Fletcher RH, Lasky T. [1984]. The incidence of primary cardiac arrest during vigorous exercise. N Eng J Med 311:874-877.



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18. Tofler GH, Muller JE, Stone PH, et al. [1992]. Modifiers of timing and possible triggers of acute myocardial infarction in the Thrombolysis in Myocardial Infarction Phase II (TIMI II) Study Group. *J Am Coll Cardiol* 20:1049-1055.
19. NFPA. NFPA 1582, Standard on medical requirements for fire fighters and information for fire department physicians. Quincy, MA: National Fire Protection Association.
20. Michaelides AP, Psomadaki ZD, Dilaveris PE [1999]. Improved detection of coronary artery disease by exercise electrocardiography with the use of right precordial leads. *New Eng J Med* 340:340-345.
21. Darrow MD [1999]. Ordering and understanding the exercise stress test. *American Family Physician*. January 15, 1999.
22. Gibbons RJ, Balady GJ, Beasley JW, Bricker JT, Duvernoy WFC, Froelicher VF, Mark DB, Marwick TH, McCallister BD, Thompson PD, Winters WL Jr, Yanowitz FG [1997]. ACC/AHA guidelines for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). *J Am Coll Cardiol* 30:260-315.
23. U.S. Preventive Services Task Force [1996]. Guide to clinical prevention services. 2nd ed. Baltimore, MD: Williams & Wilkins, pp. 3-15.
24. IAFF, IAFC [2000]. The fire service joint labor management wellness/fitness initiative. Washington, D.C.: International Association of Fire Fighters, International Association of Fire Chiefs.
25. NFPA [1997]. NFPA 1500, Standard on fire department occupational safety and health program. Quincy, MA: National Fire Protection Association.
26. 29 CFR 1910.134. Code of Federal Regulations. Occupational Safety and Health Administration: Respiratory Protection. Washington, DC: National Archives and Records Administration, Office of the Federal Register.
27. NFPA [2000]. NFPA 1583, Standard on health-related fitness programs for fire fighters. Quincy, MA: National Fire Protection Association.
28. Plowman SA, Smith DL [1997]. Exercise physiology: for health, fitness and performance. Boston, MA: Allyn and Bacon.
29. USFA [1995]. Firefighter autopsy protocol. Emmitsburg, MD: Federal Emergency Management Agency, United States Fire Administration, Publication No. FA-156.
30. NFPA [2000]. NFPA 1201, Standard for developing fire protection services for the public. Quincy, MA: National Fire Protection Association.
31. American Heart Association (AHA) [2000]. Operation heartbeat. Dallas, TX.
32. American Heart Association (AHA) [2000]. Cardiopulmonary resuscitation statistics. Dallas, TX.

INVESTIGATOR INFORMATION

This investigation was conducted by and the report written by Tommy N. Baldwin, MS, Safety and Occupational Health Specialist. Mr. Baldwin is with the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiovascular Disease Component, located in Cincinnati, Ohio.